Coarse Woody Debris Research

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Widespread riparian logging and stream cleaning operations in the late 1800s resulted in reductions in size structures, densities, and volumes of coarse woody debris (CWD) in waterways in the Upper Midwest. These reductions persist to the present, but their effects on stream and lake biota are unclear. Consequently, managers have little knowledge of how timber harvest practices have affected, and may be continuing to affect, macroinvertebrate communities in lakes and fish communities in coldwater streams. Further, managers are poorly equipped to recommend modified forestry practices that might restore losses to these communities without setting aside large blocks of unmanaged forest.

This study was designed to address the question "If volumes and sizes of CWD in coldwater streams were returned to pre-disturbance levels, how would the fish community respond to this change?" We also sought to examine the effect of wood type and forest setting category on macroinvertebrate communities inhabiting submersed CWD in lakes.

Objectives:

1. To quantify the responses of salmonid populations and associated non-game fish communities to the addition of CWD to coldwater tributaries of Lake Superior.

2. To determine the relationships between existing levels of CWD, anadromous salmonid populations and associated non-game fish communities in coldwater tributaries of Lake Superior.
3. To quantify and contrast macroinvertebrate community structure and relative abundance on CWD in lakes within unmanaged (oldgrowth) and managed (second-growth) forest settings.
4. To determine the influences of bark complexity, wood species and water depth on species composition and relative abundance of macroinvertebrates on freshly cut log substrates in several lakes in northern Wisconsin.

Methods: Wood addition component – This component measured instream channel, riparian forest, and fish community variables for three years before and three years after pieces of CWD were added to sections of three Lake Superior tributaries. Sections of three nearby streams were monitored as controls for the same variables, and three additional streams were monitored for just habitat variables. Stations that received CWD averaged about 125 m in length. Logs added were at least 2/3rds the mean width of the stream in length, were at least 20 cm in diameter, and increased the existing wood volume in the stream by at least 100%. Densities of added logs were at least 300 logs/km (37 logs per station). Fish communities were estimated by electrofishing using 3-pass depletion estimators.

Correlative component – This study component measured the same physical and biological variables as the wood addition component, but differed from that component in sampling a larger number of stations where CWD was not manipulated. The 44 stream sections sampled in this component spanned a wide range of existing densities and volumes of CWD.

Macroinvertebrates in lakes component – This study component contained two independent but related aspects. The natural aspect sampled macroinvertebrates on existing CWD in three undeveloped seepage lakes in both an oldgrowth forest setting and a second –growth forest setting. This aspect also measured riparian forest variables at each lake. The manipulative aspect determined macroinvertebrate colonization of freshly cut log substrates of four tree species that were placed in three lakes.

Preliminary Results: The data have been partially analyzed for the wood addition component and the macroinvertebrates in lakes component, but not for the correlative component.

Wood addition component – A uniform density of logs (300 logs/km) was added to sections of three coldwater tributaries to lake Superior in order to mimic undisturbed (pre-settlement) conditions in these streams and measure the responses of the fish communities, that were dominated by anadromous salmonids, to this change in habitat. The wood additions (experimental variable) increased the total amount of wood relative to the pre-existing level by variable amounts because streams contained different densities, volumes and sizes of LWD to begin with. Thus, the strongest test of the experimental variable occurred in the Little Brule River where the added wood increased the total wood volume over the pre-existing level by 684%. In Rocky Run and Whittlesey Creek the increase over the pre-existing level caused by the wood addition was less pronounced (93% and 136% increases respectively).

Monitoring of physical in-stream characteristics and fish variables for three years before and three years after the wood additions did not demonstrate clear responses of any physical channel attributes except amount of pool area, which increased in all treatment sections. No unequivocal responses by the fish communities were evident. However, these results do not mean that LWD is not beneficial to anadromous salmonid populations in these streams because sample sizes were small, the increases in wood volume in two of the treatment streams may not have been sufficient to elicit responses, and a longer post-treatment monitoring period may be necessary to allow populations enough time to adjust to the changed habitat. Further study of the influences of wood on physical and biological attributes of these streams is warranted.

Macroinvertebrates in lakes component – The focus of the manipulative aspect of this study component was primarily to test for differences in densities and species richness of macroinvertebrates colonizing freshly cut tree boles of various species that differed in the amount and kind of habitat they provided. A number of significant species associations were apparent where macroinvertebrate taxa were predominantly found on certain species of wood. However, statistical analyses have not been completed. Thus, this study aspect is likely to associate some macroinvertebrate taxa with species of CWD characteristic of oldgrowth forest settings. Significant differences were identified for several taxa that supported the concept of more complex habitats (highly decayed wood or heavily furrowed bark) having greater densities of macroinvertebrates than less complex habitats (undecayed wood or smoother bark). The results also suggested that suspension of wood vs contact with the lake bed may have been a significant factor for some taxa. For these taxa, wood in contact with the substrate had higher densities than wood in suspension. As fallen trees age they gradually lose branches, beginning with the twigs first, and eventually become more fully in contact with the bottom as large boles. Thus, the practical application of this finding could be that submerged wood becomes more attractive to some taxa as it ages for reasons independent of surface complexity.

In the natural aspect, differences among the lakes in their physical and chemical properties were of sufficient magnitude to override any categorical differences in macroinvertebrate densities or species richness between lakes according to forest setting. The differences in chemical attributes were apparently independent of the extent of timber harvest in watersheds. Consequently, this study component will not provide firm answers about differences in macroinvertebrate use of CWD between lakes according to forest-setting category. However, this study aspect will make a substantial contribution to the scientific literature because nearly 160 species of macroinvertebrates inhabiting submerged wood were identified to the species level. Prior to this study, little information was available about species of macroinvertebrates inhabiting CWD in lakes in the Upper Midwest. Testing for tree species preferences by various macroinvertebrate species is not complete, but a few statistically significant preferences are likely, including some for eastern hemlock, which only occurred in oldgrowth lakes. The species of trees represented in the CWD samples differed both

among lakes and between forest-setting categories. For example, northern white cedar was sampled commonly in some lakes but infrequently in others, regardless of forest-setting category. Conversely, eastern hemlock was sampled in all of the oldgrowth lakes, but was not sampled in any of the second-growth lakes.

Management Applications:

1. Substantial increases in wood volumes to coldwater streams (up to 684%) are unlikely to result in measurable changes to fish communities – at least in the short term.

2. Wood additions to coldwater streams can be expected to increase the amount of pool area, however, the amount of gravel substrate may not increase.

3. Some macroinvertebrate taxa are associated with certain species of submersed wood in lakes. As oldgrowth tree species, such as hemlock, are lost from riparian areas and subsequently from lakes, macroinvertebrate taxa that prefer to colonize them will be reduced or eliminated.

4. Older, more highly decayed wood provides habitat for higher densities of aquatic macroinvertebrates in lakes than newer, less decayed wood. Submersed wood becomes more attractive for macroinvertebrates as it ages. Thus, if lakeshore owners remove old submersed wood from lakes near their property, this loss of habitat for macroinvertebrates is substantial and not readily replaced as new fallen wood is recruited into the system.

5. Lake chemistry may be more important than forest setting (oldgrowth vs second-growth) in determining densities of macroinvertebrates that inhabit